EXHIBIT 10

Table of Veolia BW3 Experts Opinions Based on Biosolids
& Highlighted Excerpts from Veolia Expert Reports

Expert	Opinion/Conclusion	Cite
Dr. Gagnon	The lead service lines were the predominant sources of lead release during the flint water crisis. The biosolids data establish that lead was present in Flint's water system for many years prior to 2014. The biosolids study provides reliable, independent, and representative data that conclusively demonstrate that the removal of lead service lines was essential for decreasing water lead levels in Flint.	Gagnon Excerpt at 6, 17–23, 48.[1]
Dr. Finley	2015 Water lead levels in Flint tap water were lower than water lead levels in the pre-switch year of 2013.	Finley Excerpt at 15–17.
Dr. Bellamy	Biosolids data tend to support the reasonable assumption that there would be elevated lead release during this period of low pH and resultant poor corrosion control.	Bellamy Excerpt at 53
Dr. Masters	The low water lead levels are consistent with the low lead mass in the biosolids, confirming the validity of using biosolids as a composite sample for lead release from plumbing systems. In summary, since there were no reliable LCR monitoring results for lead before August 2015, biosolids analysis retrospectively determined that the worst lead release occurred between June-September 2014.	Masters Excerpt at 46–47, see also 9, 10, 43–46.

[1] These numbers refer to the pagination of the reports themselves.

Expert Report of Graham Gagnon, Ph.D., P.Eng.

Armview Engineering Ltd.

In Re Flint Water Cases, U.S. District Court for the Eastern District of Michigan, Civil Action No. 5:16-cv-10444-JEL-MKM (coordinated docket)

Walters, et al. v. Snyder, et al., Civil Action No. 5:17-cv-10164-JEL-MKM

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- Roy et al. (2019) and Roy and Edwards (2020), who analyzed lead contained within biosolids. Dr. Edwards' team analyzed metals data that was collected in biosolids (i.e., the solid waste generated during wastewater treatment) from the Flint Water Pollution Control Plant. Dr. Edwards' team was the first group to apply to water treatment issues an accepted concept of wastewater surveillance or wastewater epidemiology that has been used to understand illicit drug use (e.g., Been et al., 2016) and microbial pathogens such as SARS-CoV-2 (e.g., Sherchan et al., 2020). Through Dr. Edwards' analysis, it was demonstrated that there were peaks in biosolid lead concentrations in 2011 and 2014. Further, there was a decline in biosolids lead concentration in 2019 which was attributed to corrosion control and lead service line replacements in the City of Flint. In particular, Roy and Edwards (2020) stated: "The efficacy of enhanced corrosion control and replacement of service lines that contain lead is, therefore, on the order of 72–84% effective at reducing citywide lead exposure." At his deposition, Dr. Edwards explained the biosolids analysis by stating that "[i]f you look at how much lead is in the sewage, you can get an idea of how much lead was released to the drinking water every month going back for years," and that "in this article we proved that concept seemed to apply showing that the lead in the biosolids agreed with random citywide sampling events." (Edwards Dep., p. 426). The significance of the biosolids work is further explained in Section 3.2 of this report.

- Dr. Larry Russell, in his March 3, 2023 report, does not dispute that LSLs are an important source of lead in distribution systems, and LSLs were the predominant source of lead specifically in Flint in 2014 and 2015. Indeed Dr. Russell states on page 43, "It is not clear to me what this conclusion means other than LSL are a major source of lead." It is worth noting that Dr. Russell acknowledges that lead service lines are an important source of lead generally, which is consistent with best practices recommended by AWWA, APHA, and other scientific literature (as noted above).

Further, an EPA presentation on sequential sampling (Third Flint Data Summit – Region 5, January 10, 2017) noted that "[m]ost of the lead [in Flint] is coming from the service lines" and that "particulate lead yields the highest concentration of lead; particulate lead release is random/sporadic." In the same presentation, the total lead mass reduction in homes post-replacement of lead service lines was generally between 70 and 90% (with exception of two sites with 22 and 50% reduction). When sequential samples were collected, the highest lead concentrations were observed in samples from the lead service line. Consistent with other studies, there is very little evidence that would suggest that premise plumbing was a significant contributor to lead concentration at the community level in Flint. There is very little evidence in the literature that would demonstrate the benefit of replacing premise plumbing to lower lead concentrations at the community level. This presentation also conformed with data from lead monitoring results in Flint, where official Lead and Copper Rule (LCR) sampling (90th percentile first draw lead) revealed a steady decrease in lead concentrations as a result of removal of lead service lines as part of the FAST program. In 2016, lead concentrations in some samples were upwards of 20 ug/L, while as of June 2019 lead concentrations were between 2 and 6 ug/L (State of Michigan, 2020). In addition to implementing improved treatment for NOM removal coupled with corrosion control, the removal of lead service lines resulted in reductions in water lead levels to below the compliance value of 15 ug/L.

Based on analysis of lead-bearing pipe scales conducted during an EPA pipe rig study conducted by Williams et al. (2018), it is evident that that such solubility models or corrosion indices may not be appropriate. As described by Williams et al. (2018) in a discussion regarding lead scale on pipe extracted from Flint:

> Pipe scale analysis revealed the complex nature of the lead pipe scales in Flint, which contain a significant amount of amorphous material, making a priori treatment effectiveness computations and predictions essentially impossible.

In other words, the complex properties of the scale in the Flint system, as characterized by the EPA, make it nearly impossible to predict lead release using solubility models and indices like CSMR. Thus, using such metrics would not have provided reliable information on controlling lead release.

3.2 Biosolids Data Has Demonstrated the Extent of Lead Release in Flint Over Time

The biosolids analysis conducted by Dr. Marc Edwards and his team (Roy et al., 2019; Roy and Edwards, 2020) was critical in understanding the community lead burden and water lead levels (WLLs) in Flint during the water crisis and for the period of 2010-2019. Dr. Edwards utilized lead concentrations measured in biosolids that were routinely collected at the City of Flint Water Pollution Control (WPC) plant. This was the first application where biosolids monitoring was used for evaluating lead in drinking water but is based on a sound scientific approach that has been used for identifying other trace contaminants in cities for decades.

3.2.1 Background on Biosolids

Biosolids, or sewage sludge, is defined as semisolid residue left over after the treatment of municipal wastewater (Tchobanoglus et al., 2003) and is a significant waste stream produced during municipal wastewater treatment. Municipal wastewater typically is a combination of human waste and all waters that drain through a building (e.g., tap water, water from flushing toilets, bathing, dishwashing, clothes washing, etc.) from residences, institutions, and commercial establishments, and may be together with surface water or stormwater (Tchobanoglus et al., 2003. This type of wastewater generally contains an array of organic and inorganic contaminants, including metals (e.g., lead) (Tchobanoglus et al., 2003).

Untreated municipal wastewater is conveyed to a pollution control plant where it is separated into liquid and semisolid fractions, resulting in cleaner water that is safe for discharge into the environment (e.g., rivers, lakes, and oceans). The semisolid fraction that is removed during treatment is referred to as “sludge” or “biosolids” (Tchobanoglus et al., 2003). These biosolids represent a concentrated form of the solid material removed during wastewater treatment.

Municipal biosolids can act as a composite sample, capturing population level information about various contaminants of concern. According to Lorenzo and Pico (2019), wastewater biosolids can estimate drug use in a population, contain biomarkers that provide information on population habits, their health, and disease prevalence, and can also be used as a measure to evaluate human exposure to pathogens and contaminants. There have been many previous studies that have

examined biosolids for various contaminants including pharmaceutical and personal care products (e.g., Lindberg et al., 2004; Lindberg et al., 2005; Jones-Lepp and Stevens, 2007; Chen et al., 2013; Lindholm-Lehto et al., 2018), illicit drugs (e.g., Diaz-Cruz et al., 2009; Subedi and Kannan, 2014; Lai et al., 2015), and most recently viruses including SARS-CoV-2 (e.g., Balboa et al., 2021; Bhattarai et al., 2021). The scientific community has been able to understand the occurrence of these chemical and biological agents at a city level, knowing that they would represent population dynamics. In the case of SARS CoV-2 several studies have been able to demonstrate that RNA in biosolids was statistically correlated with clinical occurrence (Gerrity et al., 2021; Zhan et al., 2022; Galani et al.,2022). Through my research program at Dalhousie University, my team has developed methods to capture (Hayes et al., 2021, Hayes et al., 2022a, Hayes et al., 2022b) and detect (Parra-Guardado et al., 2022) SARS-CoV-2 in wastewater, and these methods have been applied for SARS-CoV-2 monitoring in wastewater (Hayes et al., 2021; Huang et al., 2021; Hayes et al., 2022a, Hayes et al., 2022b).

3.2.2 Biosolids as Basis to Understanding Lead in Flint

In the case of Flint, Michigan, biosolids were from the Flint Water Pollution Control Plant and were analyzed for lead by Dr. Marc Edwards' team. As described on the City of Flint webpage, the water pollution control (WPC) facility is designed to treat 50 million gallons per day (MGD) of municipal wastewater and its maximum daily flow capacity is 75 MGD (City of Flint, 2022b). When it rains, much additional flow may reach the plant. The WPC can hold about 20 million gallons of the excess water temporarily in a large storage basin. However, once the tank is full, the excess flows must be discharged. Before this water is discharged, excess flows are settled and disinfected with a bleach solution (City of Flint, 2022b). Therefore, excess stormwater is diverted from the WPC treatment, which means that stormwater would have minimal impact on the lead concentrations entering the facility.

In addition, less than 5% of the wastewater entering the WPC in the City of Flint is from industry (Roy et al., 2019). Between the period of January 2007 to October 2015, Oil Chem Inc. violated the Clean Water Act when its owner, Massey arranged for Oil Chem Inc. to receive approximately 47,824,293 gallons of landfill leachate from eight different landfills located in Michigan. One of the landfills was found to have polychlorinated biphenyls (PCBs) in its leachate (ClickOn Detroit, 2021). However, there was no reported lead violation from Oil Chem Inc. Further, over an eight-year period, the average daily flow rate from Oil Chem Inc. was 0.016 MGD, which represents 0.03% of the design flow rate at the Flint WPC. Therefore, landfill leachate from Oil Chem Inc. would have had a negligible impact on lead levels in Flint wastewater during the period that they were discharging into the system.

According to Roy et al. (2019), "*Metals (including lead) in municipal wastewater are often dominated by release from potable water plumbing… and a majority of Pb (87 ± 8%) in wastewater is typically removed during treatment and concentrated in the biosolids.*" Given that stormwater and other waste streams (e.g., Oil Chem Inc.) had a minimal expected impact on lead concentration entering the Flint WPC, the City of Flint tap water would likely have been the major source of lead in Flint biosolids. Therefore, the analysis of lead mass in biosolids collected from the Flint WPC represents a composite sample of the community-based mass of lead release from the City of Flint drinking water distribution system into its wastewater and biosolids.

Monthly metal concentrations in Flint biosolids included lead, copper, nickel, zinc, and cadmium, and were measured as mg per kg of dried biosolids. Total monthly biosolids production (kg) were obtained from the Flint WPC, and the monthly mass of metal in biosolids was calculated by multiplying the metal biosolids concentration by the total monthly production. Dr. Edwards conducted two studies analyzing lead in Flint biosolids. The first study (Roy et al., 2019) used biosolids collected from the Flint WPC from May 2011 to November 2018, and the second study (Roy and Edwards, 2020) included additional samples from January 2018 to June 2019. In Roy and Edwards (2020), the relationship between biosolids lead and water lead levels (WLL) were also modelled. These studies cover a period that captures lead in biosolids before and during the Flint water crisis (FWC), as well as after the FWC and during the removal of LSLs through the FAST Start program (e.g., March 2016 onward). Over 120 independent observations were captured in Dr. Edwards' biosolids analyses (Roy and Edwards, 2020).

The biosolids analysis represents a comprehensive analysis of Flint during the period of 2010-2019. Sample collection was similar for every month throughout that period, and it represented an aggregation of lead concentration that was not biased by sample size, sample location, sample methodology or date of sample. Further, the biosolids analysis offers different information than the 90th percentile data obtained through LCR sampling. According to Roy and Edwards (2020):

> "Official 90th percentile WLL only measures lead in the first liter from the tap (i.e., "first draw"), has used first draw sampling protocols that have changed substantially in the last few years, is calculated from sampling pool of only 60–200 "high risk" homes with lead pipe that has been changing as lead service lines (LSLs) are replaced. The official 90th percentile data is therefore designed to infrequently (once every three years to twice a year) identify a characteristic level of water lead in "worst case" homes and does not reflect average or total lead release to water across the entire city. Thus, analysis and monitoring of the lead mass in Flint biosolids is complementary, and in some ways superior to traditional in home monitoring to track progress as the Flint system continues to heal from enhanced corrosion control and LSLs are replaced.".

In the case of Roy and Edwards (2020), the estimated biosolids WLL represent a **composite 90th percentile water lead level**.

The non-biased approach for biosolids sampling is critical as it differs from other sources of information collected during this period. As described in Section 3.1, Lead and Copper Rule sampling in Flint was limited in sample size and often did not sample enough homes that contained lead service lines. Most peer-reviewed studies relied on lead data that was collected in Flint after August 2015 (Pieper et al. 2018; Lytle et al. 2019) and are not able to capture the state of lead release prior to and following the change to the Flint Water Treatment Plant. Pieper et al. (2018) collected samples that were assumed to be lead service lines based on model predictions. Other studies (e.g., Masten et al. 2016) had very limited lead data and relied on other water quality data to explain the Flint Water Crisis.

The biosolids approach demonstrated that lead was statistically related to copper in the biosolids (Roy et al., 2019). As lead and copper are present in distribution system components in

Flint, it is reasonable that these metals were statistically correlated. Not surprisingly, on average copper was about 10 times the concentration of lead in the biosolids which is consistent with the greater amounts of copper in service lines and premise plumbing relative to lead. This relationship between lead and copper provided confidence that the origin of these metals was from the distribution system. The statistical linear relationships for lead were also found between other plumbing related materials: such as zinc, nickel, and cadmium.

Figure 5 below depicts the recent biosolids data from Roy and Edwards (2020), which shows actual measured lead in biosolids (Top Figure A) and predicted water lead levels (WLL) from biosolids (Bottom Figure B) for pre, during, and post FWC.

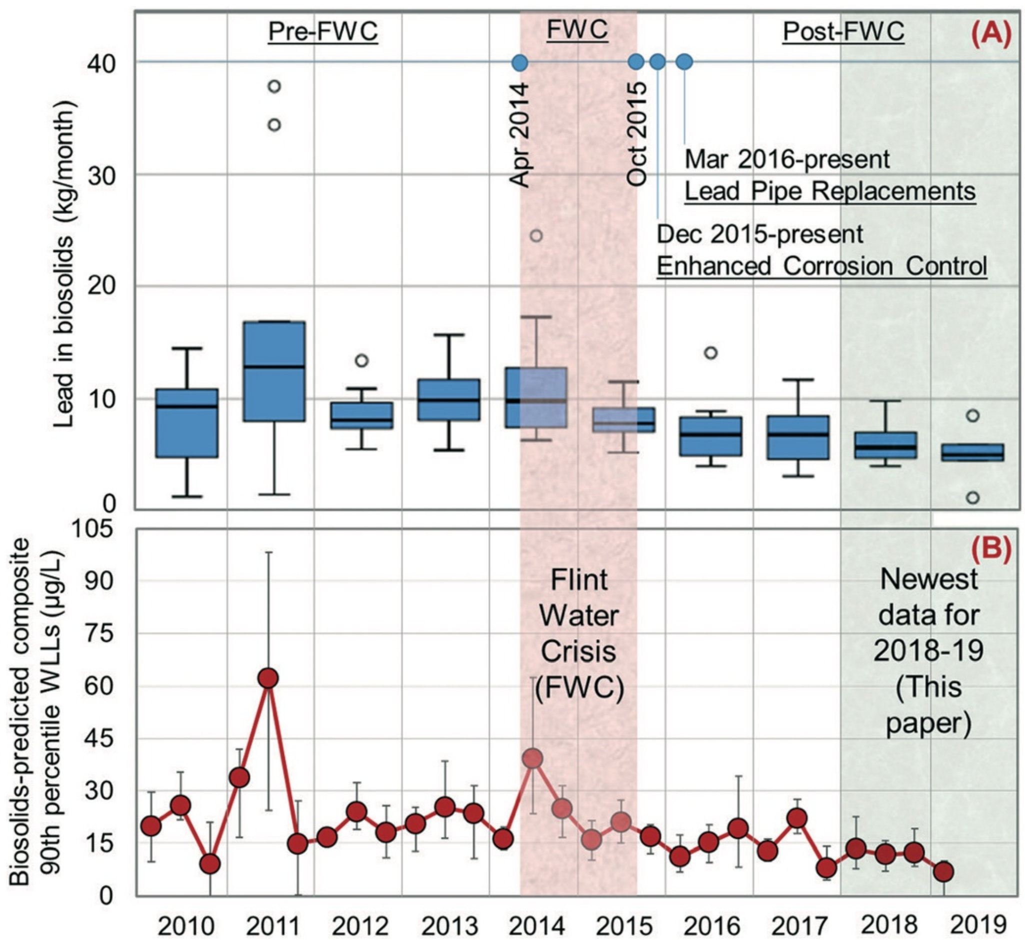

Figure 5. *Total monthly biosolids lead mass from the Flint WPC plant from 2010 to 2019 (top), and predicted water lead levels from biosolids data (bottom) (Roy and Edwards, 2020).*

Through independent analysis of Dr. Edwards research, I modified the presentation of the data from Figure 5b from Roy and Edwards (2020) to demonstrate clear patterns and observations. Figure 6 presents a visually modified version of the biosolids data reported by Roy and Edwards

(2020). As noted in the original article, each circle represented 4 months of data, except for the last data point in 2019 which Roy and Edwards (2020) represented the months of January to May.

To ease visualization, I changed the color of predicted WLLs in Figure 5 in the following manner:

- a blue dot represented the months of January to April (except for 2019, which represented January to May);
- a red dot represented the months of May to August; and
- a yellow dot represented the months of September to December.

In addition, I darkened the error bar for the period of May to August 2014 as it was difficult to see in the original figure.

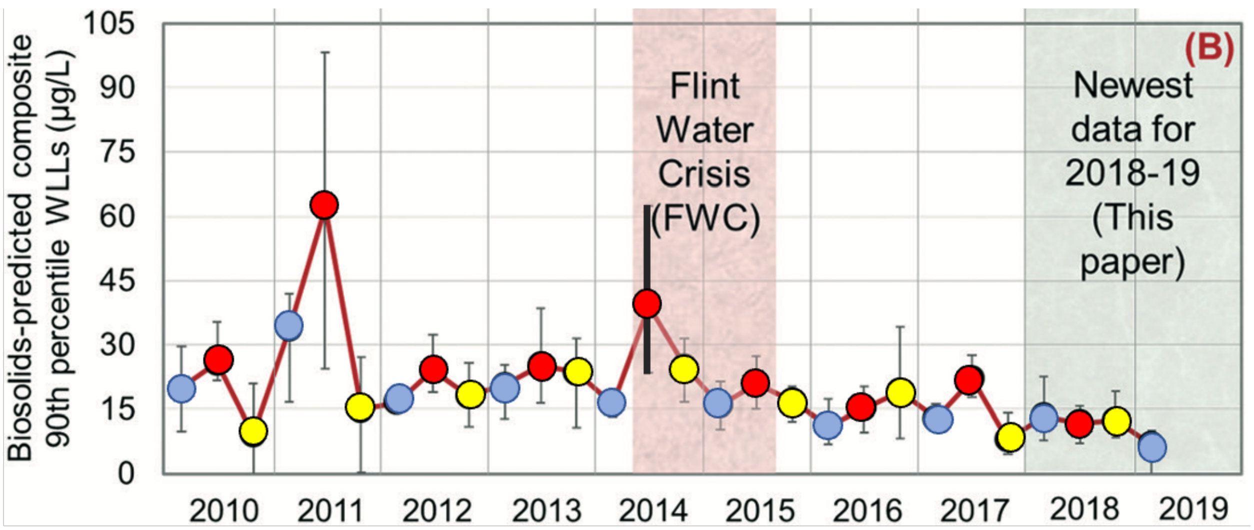

Figure 6. *Modified presentation of data from Roy and Edwards (2020) to better demonstrate trends in predicted water lead levels (WLL) obtained through biosolids analysis.*

Using this revised Figure 6 some important inferences can be established. For the period from 2010 to 2017, the expected WLL values in any given year were the highest in the months of May to August. This observation is consistent with corrosion theory, in that the temperature in Flint is warmest between May and August (Figure 7), and corrosion processes including scale release are known to increase with water temperature. This relationship between lead and temperature has been reported in scientific literature (e.g., Masters et al., 2016) and is also the reason that the Lead and Copper Rule requires sampling during summer months. Because this trend is consistent with corrosion theory, it further grounds observations by Roy and Edwards (2020) that biosolids were a reasonable predictor of community lead occurrence.

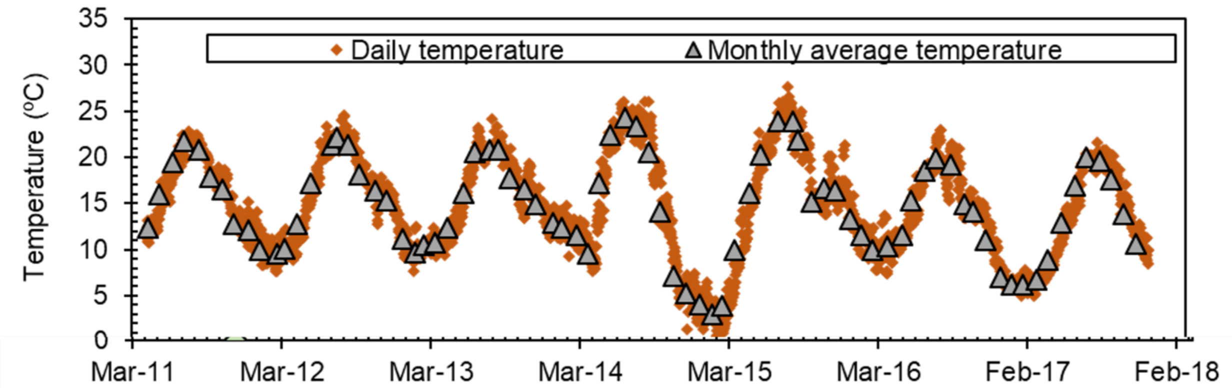

Figure 7. *Modified from Figure S1 appearing in Roy et al. (2019).*

The biosolids analysis revealed several other important observations:

- The expected WLL value in summer 2011 was higher than the expected WLL value in summer 2014.
    - Roy et al. (2019) noted that "a key point is that both biosolids lead and %EBL5 spiked higher in 2011 than at any other point reported in this research, including during the FWC".
    - In 2011, LCR data sampled an inadequate number of Tier 1 sites, and a low number of samples relative to the population size (as described in Section 2.1.2). Therefore, it is entirely possible that the WLL estimate by Roy and Edwards (2020) more accurately represents lead levels in Flint in 2011.
- The expected WLL value for the summer 2012 and summer 2013 also exceeded 15 µg/L. Given the biosolids data presented for the summer periods of 2011, 2012, and 2013, it is uncertain whether Flint had effective corrosion control for lead during this time period.
- After the levels spiked in summer of 2014, they went back down to pre-crisis levels by 2015, before VNA came to Flint.
- The expected WLL value in summer 2018 was the only summer that was not greater than 15 µg/L during the sampling period, which was likely a consequence of lead service line replacements.
- The lowest expected WLL value occurred in Jan – May 2019, which would be the greatest accumulation of lead service lines replacements in Flint as identified through the FAST program.

For the following reasons, biosolids are an important information source for understanding lead occurrence in Flint:

- Reliability. Unlike many water quality studies and regulatory reporting, the biosolids are reliable. The samples were collected in the same manner and at the same location every month for a decade.

- Independence. The biosolids data do not have a sample bias. Unlike much water quality sampling activity that purposely attempted to sample homes with lead service lines or regulatory sampling that did not sample enough lead service ling homes, the biosolids data is a non-discriminative sampling pool.
- Representative. The biosolids data are representative of lead corrosion. Within a given year, lead concentrations are highest in the summer (warm water periods) and lowest in the winter (cold water periods). Further the lead concentration in biosolids was significantly correlated with the copper concentration in biosolids during the period of 2010-2016. As lead service lines were removed there was a decoupling of linear relationship between lead and copper during the period of 2018-2019. Collectively these observations indicate that lead concentrations were related to lead release from service lines.
- Outcome. In the case of Flint, the biosolids data establish that lead was present in Flint's water system for many years prior to 2014. Further, the biosolids data establish that once the FAST Program was initiated in March 2016, decreased community lead occurrence was observed in Flint in 2018 and 2019.

The biosolids study provides reliable, independent, and representative data that conclusively demonstrate that the removal of lead service lines was essential for decreasing water lead levels in Flint.

3.3 Lead Release and Natural Organic Matter

Natural organic matter (NOM) is present in virtually all drinking water sources, but its concentration and chemical properties vary from source to source. The origins of NOM also vary and may include sediment, surface runoff, and aquatic or terrestrial plants and/or animals. Microorganisms in surface water sources can also produce NOM. The origins of NOM affect its chemical properties and its removal during drinking water treatment. For example, natural organic matter generated through the decomposition of plant material is generally humic in nature and is known to have hydrophobic (dislikes water) properties. On the other hand, microbially produced (biogenic) natural organic matter tends to be hydrophilic (water-loving).

Exposure to NOM in drinking water is very common and is not associated with direct health effects. However, the presence and characteristics of NOM have significant impacts on drinking water treatment processes aimed at protecting public health. Health Canada (2019) noted that NOM can contribute indirectly to health impacts in drinking water through the following pathways:

- a deterioration of pathogen removal capability due to increased coagulant demand, which can lead to suboptimal coagulation conditions;

- a deterioration of pathogen inactivation capability due to chemical disinfectant demand or interference with ultraviolet (UV) disinfection;

- the formation of disinfection by-products (DBPs);

- the development of distribution system biofilms that can harbor pathogens; and

4 Conclusions

In summary, based on my review of available information, I conclude within a reasonable degree of scientific certainty that:

- Lead service lines were the predominant source of lead in Flint.

- The FAST program sheds light on the extent to which lead occurred in Flint from private service lines (owned by homeowners) and from public service lines (for which the City of Flint was responsible) and continues to show that private LSLs represented a relatively small portion of overall service.

- Through comparing LCR data to FAST Start program data it was clear the City of Flint was not compliant with LCR sampling requirements because it avoided sampling Tier 1 homes (those with an LSL) and sampled a very low number of homes (less than 100). Therefore, an inappropriate sample pool was used for LCR sampling and demonstrating compliance with the LCR. This brings uncertainty and unreliability to the LCR data for data prior to 2014.

- The biosolids data discussed covers a period that captures lead before, during, and after the Flint Water Crisis. Over 120 independent observations were captured in Dr. Edwards' biosolids analyses. Sample collection was similar for every month throughout that period, and it represented an aggregation of lead concentration that was not biased by sample size, sample location, sample methodology or date of sample. Further, the biosolids suggest that Flint had a high lead concentration in several years prior to 2014. Further, the biosolids data establish that once the FAST Program was initiated, decreased community lead occurrence was observed in Flint, as the removal of lead pipes in Flint has significantly lowered lead exposure through drinking water in the City of Flint.

- Lead release in Flint was predominantly from pipe scale that had accumulated on the lead service lines over the long history of the Flint distribution system. The scale contained significant quantities of lead. However, the nature of the scale was amorphous and non-uniform, which resulted in unpredictable release not predictable or describable by theoretical models.

- Indices such as LSI and CSMR are generally not exclusively relied upon for corrosion control in the water industry, and within the context of Flint – which was characterized by amorphous scale on lead pipe surfaces – these indices would in and of themselves have been inconclusive and unreliable for indication of any systemic lead release issues.

- Natural organic matter (NOM) had a significant role in water quality in Flint. High concentrations of NOM resulted in violations of disinfection by-products in Flint. VNA correctly identified that removing NOM would be critical to improving drinking water quality overall and would decrease disinfection by-product concentrations in Flint.

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behind from removing old buildings were filled with clean soil, and no receipts showing that the hazardous materials were taken to the appropriate landfills (SIGTARP 2017). Regarding dust suppression, the Corps reported witnessing "on going wetting" at one of the in-progress demolitions (SIGTARP 2017). However, Flint did not require contractors to submit plans for dust and noise control as they were required to do under the Scope of Work. Accordingly, I have little confidence that the Flint demolition activities followed proper protocols to minimize the release of lead-based paint into the surrounding communities.

In summary, brief seasonal (3rd quarter) peaks in BLLs occur every year in Flint children, due to soil, house dust, and house paint exposures. In my opinion, the demolition activities in areas of downtown Flint with a high density of blighted structures caused or contributed to the 3rd quarter BLL peaks in 2014 and 2015 being higher than in previous years.

Opinion #2: Several studies have evaluated water lead levels (WLLs) and BLLs in Flint children before and during the April 2014–October 2015 switch to Flint River water. The weight of evidence indicates that tap water consumption did not cause an increase in Flint children BLLs in 2015.

In this opinion, I evaluate the weight of evidence regarding the existence of a relationship between WLLs and child BLLs during the switchover period in Flint. Particular emphasis is given to the year 2015.

2015 WLLs in Flint tap water were lower than WLLs in the pre-switchover year of 2013

Two recent studies have reported a comprehensive analysis of Flint WLLs before and during the switchover: Roy et al. (2019) and Roy and Edwards (2020b). In Roy et al. (2019), the investigators found a strong temporal correlation between particulate WLLs measured in tap water versus the mass of particulate lead in biosolids collected at the Flint wastewater treatment plant in 2015 and 2016. They used this relationship to estimate 90th percentile WLLs in Flint for several years prior to and throughout the switchover period based on the biosolids lead data that had been measured during those periods. All wastewater sources (kitchen and bathroom taps, washing machines, flushed toilets, dishwashers, bathtub and shower drains, etc.) contribute to the daily mass of wastewater lead released by each residence. The 2020 paper is simply an update that presents more recent measured data for 2018 and 2019 (well after the switchover period). Figure 7 below is Figure 1B from Roy and Edwards (2020b).

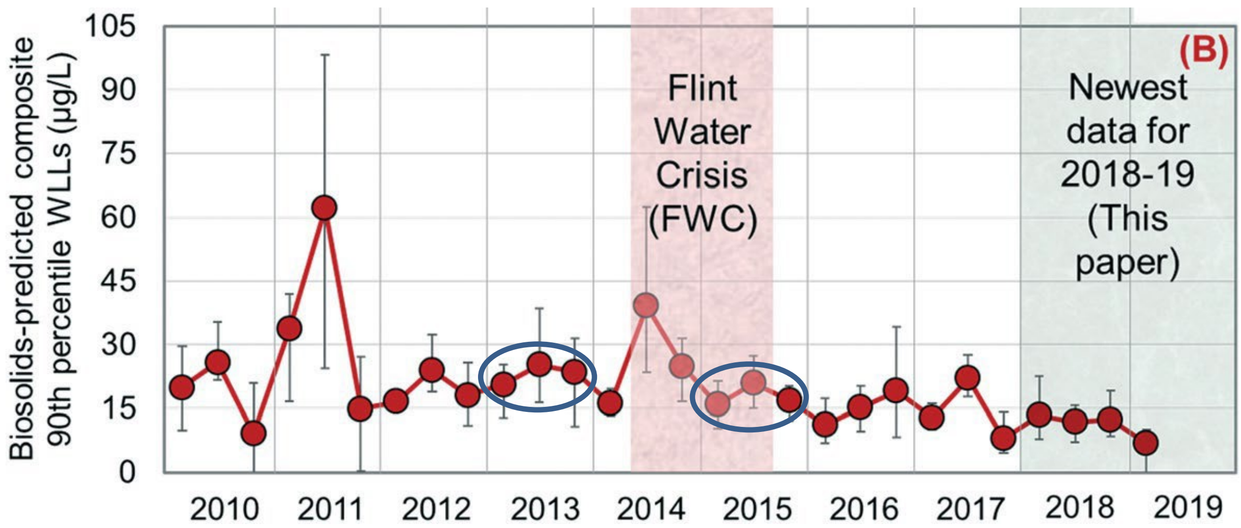

Figure 7. *Measured and estimated WLLs in Flint. Figure 1B from Roy and Edwards (2020b).*

As can be seen in Figure 7, Roy and Edwards (2020b) reported a large WLL spike in 2011; the WLLs then returned to a relatively steady "baseline" level throughout 2012 and 2013 until there was another, smaller, WLL spike in 2014. The timing of the 2014 WLL spike coincides with the switch to Flint River water. The 2014 WLL spike then subsided to a baseline level before the end of 2014 and the WLLs have remained at a slowly decreasing baseline level ever since.

In his prior deposition testimony, Dr. Edwards noted that it was a "surprise" and "kind of shocking…that the lead in water levels in Flint weren't worse" (Edwards 8/07/2020: p. 258, p. 259, l. 22, 24). He stated that "Flint children were exposed to extreme lead levels for only a short time and probably weren't seriously affected, which in turn should reduce stress levels amongst Flint parents about how much the lead crisis affected their kids" (Edwards 8/07/2020: p. 315, l. 2-6). He added that there were "a few cases where…you have excess exposure to lead, but in the grand scheme of things that lead exposure historically was not as bad as initially feared" (Edwards 8/07/2020: p. 315, l. 22-p. 316, l. 2).

As described later in this report, the brief nature of the 2014 WLL spike is consistent with the fact that most homes in Flint have copper service lines and therefore most homes in Flint had little if any lead to mobilize from their service lines. Roy et al. (2019) reported that less than 5% of Flint wastewater is derived from industry, suggesting that the lead detected in biosolids originated from residential plumbing as opposed to legal or illegal industrial sources. Dr. Edwards clarified in his deposition that, in addition to lead, he analyzed samples for four other metals that are indicative of residential plumbing; all five of these metals demonstrated the same spike in 2014 (Edwards 8/10/2020: p. 436-437). He noted that it was "very unlikely that an industry would…not just put lead in the water but also everything else related to [residential] plumbing, including these…metals" (Edwards 8/10/2020: p. 436, p. 437, l. 1-4).

By 2015, the WLLs had returned to baseline levels. Although Gomez et al. (2019b) reported that

residential water consumption in Flint in 2015 was 67% lower than in 2013, the precipitous decrease to baseline WLLs by the end of 2014 was *not* due to residents switching to bottled water, because tap water is a relatively minor contributor to the daily amount of wastewater lead released by a residence (due to much larger contributions from sources described above). The 2015 baseline WLLs are somewhat lower than the 2013 baseline WLLs. After 2015, the baseline WLLs continued to decrease with the removal of lead pipes that began in March 2016 with the FAST Start program.

Roy et al. (2019) made specific reference to the Lead and Copper Rule (LCR) sampling that occurred in Flint prior to the switchover, noting that it was "nearly useless" because the results were biased low due to 1) failure to meet the requirement that at least 50% of the samples be collected from homes with lead-containing service lines, and 2) pre-flushing of the tap lines before sample collection. Dr. Edwards further noted in his deposition that the City of Flint used small-mouthed sampling bottles, selectively sampled from a relatively new water main, and excluded a high data point (Edwards 8/10/2022: p. 455-456). In short, it is now understood today that any suggestion that the pre-switchover WLLs in Flint were non-detect based on the non-compliant LCR sampling data is invalid.

Relationship between Flint WLLs and child % EBLLs in 2014 and 2015

The term "% EBLL" refers to "percentage of individuals with elevated BLL"; the definition of "elevated" typically refers to the CDC reference level. For example, at the time the Laidlaw et. al. (2016) analysis was conducted, the CDC reference level was 5 µg/dL and therefore Laidlaw defined % EBLL as % BLL > 5 µg/dL. Unless otherwise noted, the same definition will be used throughout this report.

The % EBLL and WLL spikes that occurred upon switching to Flint River water in April 2014 (Figures 5 and 7, respectively) were temporary, i.e., both metrics returned to baseline (pre-switchover levels) before the end of 2014. Although the 2014 % EBLL spike also returned to baseline quickly and contemporaneously with the WLL trend, the primary reason the % EBLL returned to baseline was not related to the decrease in the WLLs but was due instead to the fact that the 2014 % EBLL spike was primarily driven by the temporary, cyclic increase/decrease in soil and dust exposure that occurs in the 3rd quarter of every year. It is more likely than not that the 2014 3rd quarter % EBLL spike was higher than in previous years due to increased exposures to lead-containing soils and dusts as a result of the demolition that occurred throughout that year. While it cannot be ruled out that decreasing WLLs and/or residents switching to bottled water may have contributed to the 2014 % EBLL spike decrease, in my opinion these factors had little or no influence on the 2014 % EBLL spike decrease and the 2014 % EBLL would have returned to baseline quickly regardless.

Unlike in 2014, in 2015 there was no WLL spike and in fact the WLLs throughout 2015 were lower than the pre-switchover WLLs in 2013 (Figure 7 above). Therefore, the 2015 WLLs were not influenced by the temporary switchover to Flint River water. Accordingly, the 2015 % EBLL peak was not related to tap water consumption. Indeed, given the ongoing issues with tap water color,

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"Bellwether 3 Trial"

Introduction

Scope of Engagement

I am engaged on behalf of Veolia North America (VNA) by Campbell Conroy & O'Neil, P.C. to provide engineering consultant services to evaluate materials and testify, if required, regarding pending litigation. My billing rate is $250 per hour for office work, $350 per hour for testimony. Expenses are reimbursed without markup. My scope-of-service to evaluate materials has varied according to the timing of discovery, expert reports, and testimony. Conclusions and opinions are my own. In the last 4 years, I have testified at trial or deposition in the following matters:

- Trial testimony in the "Bellwether I" trial in the Flint litigation June 29, 2022.
- Deposition testimony related to my class certification-stage report in the Flint litigation February 22, 2021.
- Deposition testimony related to Class and BW3 combined deposition April 27, 2023.

Qualifications

I am an adjunct Professor of Practice and Deputy Director of the Center of Excellence in Produced Water Management at the University of Wyoming, as well as the owner and sole employee of Bellamy and Sons. I am a registered Professional Engineer (P.E.) and a Board Certified Environmental Engineer (BCEE) by the American Academy of Environmental Engineers (AAEE). I have 40 plus years of experience as a professional design, operations, construction engineer, and planner with a drinking water and wastewater focus. My organizational participation includes CH2M Hill, Texaco Inc, Aramco Saudi Arabia, US Army Medical Services (Environmental Hygiene Agency), and the US EPA. I specialize in the application of sustainable facility development and assessment principles for municipal, government and industrial clients globally. I have published and presented over 150 articles, papers, and presentations on

Biosolids[126] data tend to support the reasonable assumption that there would be elevated lead release during this period of low pH and resultant poor corrosion control. Also shown are the low and variable pH values in the summer and fall of 2015 (especially August and September). These pH values demonstrate a substantial change in water treatment from those identified by VNA while in the CoF. As with the previous low and variable pH values in 2014, lead corrosion control issues can be expected. Investigations during this period demonstrated that there was a lead corrosion control problem.

Of note are the elevated pH values in October through December, 2014. This 3 month period had the highest pH values and lowest temperatures and in December the CoF collected the LCR samples. The 90th percentile compliance value for lead in the 100 samples was 6 ug/L. Also, from June to December the pH rose steadily to the elevated values witnessed by VNA. It was a reasonable conclusion for VNA to have reached that the higher pH/alkalinity and low temperature was successful for corrosion control based on the LCR results.

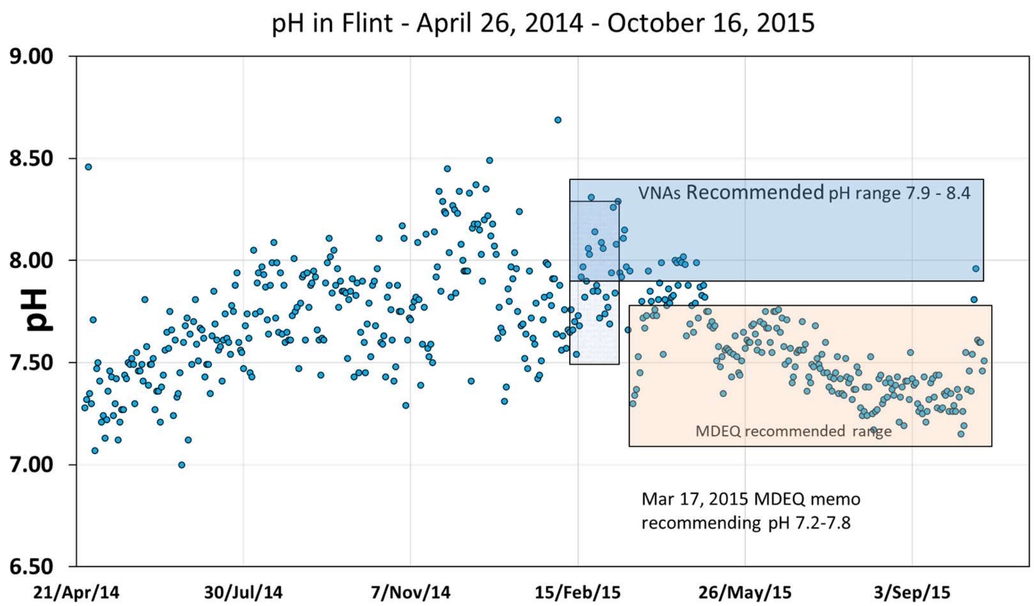

Figure 4 Flint pH values 2014 - 2015.

[126] Roy, Siddhartha, Edwards, Mark, A., Efficacy of corrosion control and pipe replacement in reducing citywide lead exposure during the Flint, MI water system recovery. Environmental Science Water Research & Technology, 2020.

Expert Report of Sheldon V. Masters, Ph.D.

(Bellwether 3)

In Re Flint Water Cases,
U.S. District Court for the Eastern District of Michigan
Civil Action No. 5:16-cv-10444-JEL-MKM
(coordinated docket)

Walters, et al. v. Snyder, et al., Civil Action No. 5:17-cv-10164-JEL-MKM
"Bellwether 3 Trial"

July 26th, 2023

under worst-case normal household use the optimal stagnation time should reflect the longest stagnation period typically observed in an individual household rather than a maximum time specified by the utility. The Flint LCR sampling instructions stated that "we do not recommend sampling if the faucet has sat idle for more than 12 hours." Based on this instruction, some residents may not collect samples during periods where their water has sat stagnant for more than 12 hours. Previous studies have shown that lead levels can continue to rise beyond a 12-hour stagnation period, and therefore, higher lead concentrations could be missed.

Sample Bottle Type. The LCR specifies the sample volume (1-liter) but not the type of sample bottle opening that must be used. Wide-mouth bottles offer an advantage over narrow-mouth bottles by allowing for sample collection at a high flow rate. This sample is more representative of consumer use and is more likely to capture particulate and colloidal lead as well as elevated lead levels (Grumbles, 2004; U.S. Environmental Protection Agency, 2021). Sources have indicated that for lead compliance sample collection, Flint used small narrow mouthed bottles during the period of time when the city appeared to have a 90th percentile below the action level (FWATF, 2016; Pieper et al., 2017). This type of bottle was not explicitly banned under the LCR, but the practice of using narrow-mouthed bottles in Flint likely missed worst-case lead levels. The MI LCR and the LCRR now specify the use of wide-mouth bottles.

The culmination of the monitoring and sampling deficiencies identified above resulted in the lead 90th percentile in Flint likely being lower than it would have been if the regulatory requirements and EPA guidance were being followed. As a result, elevated lead levels and a 90th percentile lead exceedance went unidentified for more than a year, and compliance results reasonably relied upon by VNA engineers likely did not provide an accurate picture of lead corrosion in the period July to December 2014. In August 2015, Virginia Tech researchers conducted a system-wide sampling in direct collaboration with Flint residents. The sampling protocol used by Virginia Tech followed standard practices that would increase the likelihood of capturing high lead (i.e., no pre-stagnation flushing, using widemouthed bottles, not establishing a maximum stagnation time). As a result, they were able to capture lead levels that were more reflective of the actual lead release in Flint. Specifically, Virginia Tech's lead 90th percentile for samples collected in August was 27.0 ppb compared to 6 ppb and 11.4 ppb in the 2014 and 2015 compliance sampling rounds done by the city, respectively. The Virginia Tech results were significantly higher than the official compliance results despite the fact that Virginia Tech did not target Tier 1 sites.

PART 2: TIMELINE OF LEAD RELEASE IN FLINT, MI

Lead Release after Switch to Flint River (April 2014 to August 2015). Because the historic LCR sampling results in Flint are unreliable due to sampling and monitoring deficiencies, they cannot be used to assess composite lead release. Compliance sampling also occurs too infrequently and does not usually collect enough samples to assess short-term lead release trends over the course of weeks or months immediately after a source water switch. However, two studies were able to retrospectively determine the composite lead release immediately after the source water change using routine biosolids monitoring data obtained from wastewater treatment plant biosolids (Roy et al., 2019; Roy and Edwards, 2020). The researchers found that "***the "worst" lead exposure during the FWC***

[Flint Water Crisis] was restricted to June-August 2014 (captured in biosolids lead mass during July-September 2014), as is further confirmed by the significant elevation in %EBL5 associated with those months." They also go on to acknowledge that "***The overall biosolids lead data directly contradicts prior speculation by ourselves and others, that water lead levels and associated exposures, progressively increased during the 18 months of the FWC. Our analysis can also help put the potential exposures occurring during the FWC into context, versus routine USEPA 90th percentile.***"

Trends in Water Lead Levels (August 2015 to September 2019). Sampling data from the 4 Virginia Tech sampling events (August/September 2015 and March, July, and November of 2016) were combined with data obtained from the MDEQ's website to assess trends in lead release between August 2015 and September 2019. Only first draw data were included in my analysis. It is my understanding that these MDEQ data were collected using standard sampling protocols that did not include pre-flushing (Milman, 2016; Williams, 2015). The results indicate that, for homes with LSLs, the 90th percentile water lead levels did not drop below the action level until July 2016. This was despite that fact that the source water was switched back to the Detroit source in October 2015 and the orthophosphate dose in Flint was boosted to triple the dose in Detroit starting December 9th, 2015. After January 2018, the lead concentrations in Flint appear to be historically low given that the 90th percentile lead concentration at high-risk sites was between the method reporting limit and 4 ppb. These lead levels are within the range of other large cities with LSLs that are supplied by surface water treated with orthophosphate (Bradley and Horscroft, 2018; DC Water, 2023), including Detroit (90th percentile in 2008, 2011 and 2014 were 4.8 ppb, 3.4, ppb and 2.3 ppb, respectively) prior to the new sampling protocol specified in the MI LCR (Detroit Water and Sewerage Department, 2018).

PART 3: LEAD OCCURRENCE IN LARGE BUILDINGS AND THE UNIVERSITY OF MICHIGAN-FLINT

Occurrence of Lead in Large Buildings

Numerous studies have found elevated lead levels above the EPA's action level in large buildings (Boyd et al., 2008; Bryant, 2004; Elfland et al., 2010; Horst-Martz et al., 2022; Latham and Jennings, 2022; Miller-Schulze et al., 2019; Triantafyllidou et al., 2014; Triantafyllidou and Edwards, 2009). According to the U.S. EPA, "**large buildings such as schools can have a higher potential for elevated lead levels because, even when served by a water system with well operated OCCT, there may be longer periods of stagnation due to complex premise plumbing systems and inconsistent water use patterns**" (U.S. Environmental Protection Agency, 2021). Some studies found lead levels more than 1,000 ppb in large building systems served by utilities having optimized corrosion control. Large buildings usually do not contain lead service lines and, in most cases, the sources of lead in these large buildings were from brass fixtures and fittings (including "lead-free" fixtures) and copper with lead solder.

Lead Results at University of Michigan-Flint and other Large Buildings

In February 2015, VNA engineers received 15 lead sampling results collected January 9th, 2015, at several buildings on the UM-Flint campus in downtown Flint. VNA reviewed the results even though these data are not a part of the approved LCR monitoring sites

2 TIMELINE OF LEAD RELEASE IN FLINT, MI

2.1 CHALLENGES WITH USING COMPLIANCE DATA TO ASSESS LEAD RELEASE IN FLINT

LCR sampling in Flint, MI was unlikely to capture trends in composite lead release due to sampling and monitoring deficiencies as well as long gaps between sampling periods which is inherent to the rule. Firstly, first-draw samples may not always capture water in contact with a LSL (Lytle et al., 2019; Masters et al., 2021; Triantafyllidou et al., 2021). Compliance sampling also occurs too infrequently and does not usually collect enough samples to assess short-term lead release trends over the course of weeks or months immediately after a source water switch. In Flint, the issue was particularly problematic since no lead samples were collected within 6 months after the source water change. Even though the monitoring period was from July to December, the first lead samples were not collected until November 2014, more than 6 months after the switch. This delay in sampling missed any immediate spike in lead release that occurred and made it less likely to identify elevated lead since samples were collected in colder months.

Sampling and monitoring deficiencies in Flint, MI discussed in Section 1 would have made this even more difficult. Particularly, not sampling from the same sites, not sampling from Tier 1 sites, pre-stagnation flushing before sample collection and the use of small-mouthed bottles. Since compliance results cannot be relied upon to assess lead release trends, I relied on peer-reviewed studies (Pieper et al., 2018; Roy et al., 2019; Roy and Edwards, 2020) and independent data using standard sampling approaches to assess lead release trends in Flint, MI.

2.2 LEAD RELEASE AFTER SWITCH TO FLINT RIVER (APRIL 2014 TO AUGUST 2015)

Since the City of Flint did not collect samples immediately after the source water change, there is no water lead data that is available to determine whether there was a significant increase in lead release after change. Furthermore, because of the deficiencies in the compliance sampling done in 2014 and 2015 there is no reliable water lead data to assess lead release from April 2014 to August 2015. However, two studies were able to retrospectively determine the composite lead release immediately after the source water change using routine biosolids monitoring data obtained from wastewater treatment plant biosolids (Roy et al., 2019; Roy and Edwards, 2020). A key assumption of these studies is that metals from the corrosion of plumbing materials (i.e., lead, copper, cadmium, nickel, and zinc) is a major contributor to metals in wastewater biosolids which has been verified by other researchers (Isaac et al., 1997). In addition to lead and metals from plumbing systems there are several other potential sources of metals that can end up in the sewage system and the produced biosolids. However, the researchers accounted for these confounding factors that could impact the results including whether the sewerage system was a combined system, rain events, and other lead sources from industry.

Roy et al. (2019) found that the mass of potable plumbing-related metals (i.e., lead, copper, cadmium, nickel, and zinc) measured in the sewage biosolids strongly correlated with one another during the Flint Water Crisis. This signature supports their hypothesis that a significant portion of those metals were from the corrosion of plumbing materials and therefore could be used as a fingerprint for lead release in Flint. They further

validated that metals in the biosolids could be used as a composite sample of lead release by correlating lead in the biosolids with tap sampling events. Specifically, the researchers conducted five city-wide tap water sampling events using a three-bottle first, second and third draw protocol executed in a citizen science collaboration between Flint residents and the Virginia Tech team in August/September 2015, March 2016, July 2016, November 2016 and August 2017. The researchers calculated a representative weighted average 90th percentile water lead level (WLL90) using a weighted average of 1/3 x (90th percentile first draw lead), 1/3 x (90th percentile second draw lead) and 1/3 x (90th percentile third draw lead), to reflect importance of lead release from all three types of water in human exposure. The WLL90 calculated from each round of citywide citizen science sampling and the monthly lead in biosolids were strongly correlated (Pearson's correlation coefficient (R) = 0.93, $p < 0.05$). Based on their analysis, Roy et al. (2019) were also able determine that lead in biosolids reached a peak during the warmer months (May-October) of the crisis in 2014, after which lead release steadily declined. The average and maximum lead in the biosolids during the Flint Water Crisis in 2015 were comparable to those before the Flint Water Crisis in the summer of 2012 and 2013 which suggests that water lead levels declined from the start of the Flint Water Crisis in summer 2014 as lead was sloughed from pipe scales.

Figure 16 shows the timeline of lead release from plumbing in Flint measured from biosolids and events related to lead release (e.g., source water changes). Specifically, the source water was switched back to the Detroit source in October 2015, the orthophosphate dose was tripled in December 2015 and lead pipe replacements began in March 2016 under the Flint FAST Start program (Roy and Edwards, 2020). Between May 1-15, 2016 a "Flush for Flint" program was conducted to clean lead sediments from home plumbing systems (Mantha et al., 2020; Pieper et al., 2018; U.S. EPA, 2016). Residents were instructed to begin flushing by running the cold water in the bathtub for 5 minutes since bathtubs have a significantly higher flow rate than other outlets and higher flowrate will mobilize lead particles (Brown, 2015; Cartier et al., 2012; Masters et al., 2016a; Triantafyllidou and Edwards, 2012). In January 2017, faucet replacements began to remove older fixtures with "lead-free" brass that is allowed to have up to 0.25% lead (Ansari, 2017; Dolan, 2016; Roy and Edwards, 2020). These "lead-free" brass faucets will likely reduce the amount of lead release to drinking water in the long run but can still be a source of lead in drinking water (Neltner and McCormick, 2019; Ng and Lin, 2016; Parks et al., 2018).

All the aforementioned events impacted the amount of lead and other plumbing related metals that ended up in the biosolids but Roy et al. (2019) noted that "***the "worst" lead exposure during the FWC was restricted to June-August 2014 (captured in biosolids lead mass during July-September 2014), as is further confirmed by the significant elevation in %EBL5 associated with those months.***" They also go on to acknowledge that "***The overall biosolids lead data directly contradicts prior speculation by ourselves and others, that water lead levels and associated exposures, progressively increased during the 18 months of the FWC. Our analysis can also help put the potential exposures occurring during the FWC into context, versus routine USEPA 90th percentile.***"

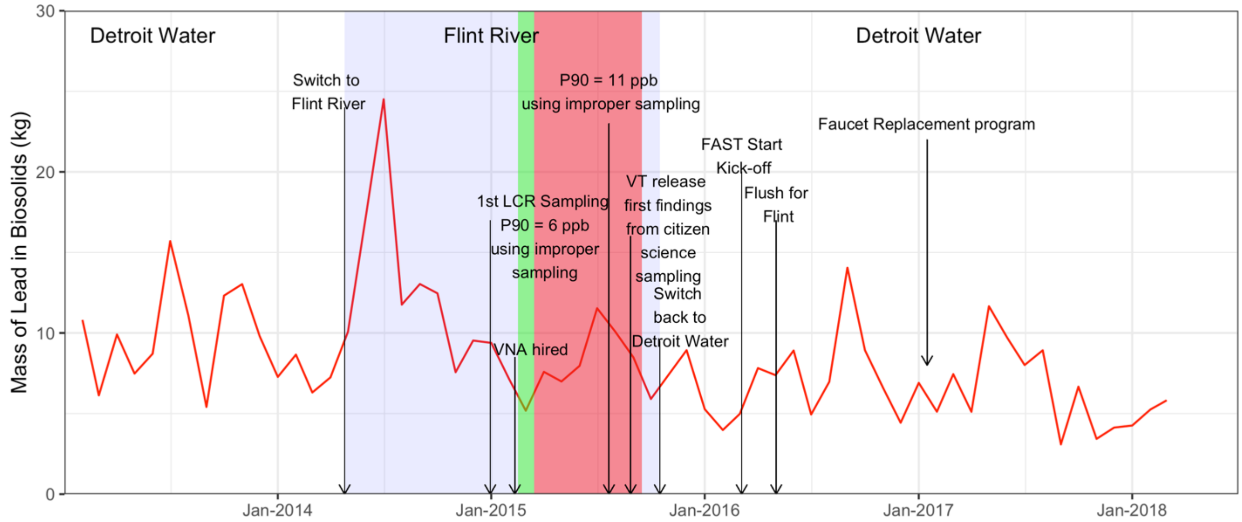

Figure 16. Mass of lead in biosolids over time along with several events. Blue shading = Period on Flint River, Green shading = Period of VNA involvement, Red shading = period of pH and alkalinity decrease.

2.3 TRENDS IN WATER LEAD LEVELS (AUGUST 2015 TO SEPTEMBER 2019)

Sampling data from the 5 Virginia Tech sampling events were combined with data obtained from the MDEQ's website to assess trends in lead release between August 2015 and September 2019. Only first draw data were included in my analysis. In August and September 2015, Virginia Tech conducted the first reliable large-scale household lead sampling after the switch to the Flint River source. Virginia Tech subsequently conducted 3 additional sampling rounds in March, July, and November of 2016. The Virginia Tech sampling protocol instructed residents to collect a 1-L sample from a drinking water tap (e.g., kitchen or bathroom faucet) after a minimum 6-hour stagnation. After the first-draw sample, residents were instructed to flush the tap for 45 seconds and collect a 500 mL sample; and flush the sample tap for an additional 2 minutes and collect a 125 sample (Pieper et al., 2018). It is my understanding that MDEQ lead monitoring data collected after fall 2015 were collected using standard sampling protocols that did not include pre-flushing (Milman, 2016; Williams, 2015). The MDEQ results included first draw lead data in addition to calculated first draw from the weighted average of a 250 mL and 750 mL first and second draw.

Figure 17 shows the monthly 90th percentile water lead levels for first draw samples for all sites and sites with LSLs. Figure A - 1 and Figure A - 2 in the Appendix show boxplots of the lead concentrations all service line compositions and LSLs in Flint, respectively. Table A - 1 and Table A – 2 in the Appendix show the summary statistics for monthly first draw lead concentrations in Flint. The results in Figure 17 indicate that, for all sites and for homes with LSLs, the 90th percentile water lead levels did not drop below the action level until July 2016. This was despite the fact that the source water was switched back to the Detroit source in October 2015 and the orthophosphate dose in Flint was boosted to triple the dose in Detroit starting December 9th, 2015 (Roy and Edwards, 2020). After January 2018, the lead concentrations in Flint appear to be historically low given that the 90th percentile lead concentration from all lead sources (i.e., brass, copper with lead solder and LSLs) and at high-risk sites (i.e., LSL sites) was between 1 ppb and 4 ppb

(Figure 17). The low water lead levels are consistent with the low lead mass in the biosolids, confirming the validity of using biosolids as a composite sample for lead release from plumbing systems. Note that samples below the detection limit were replaced with 1 ppb.

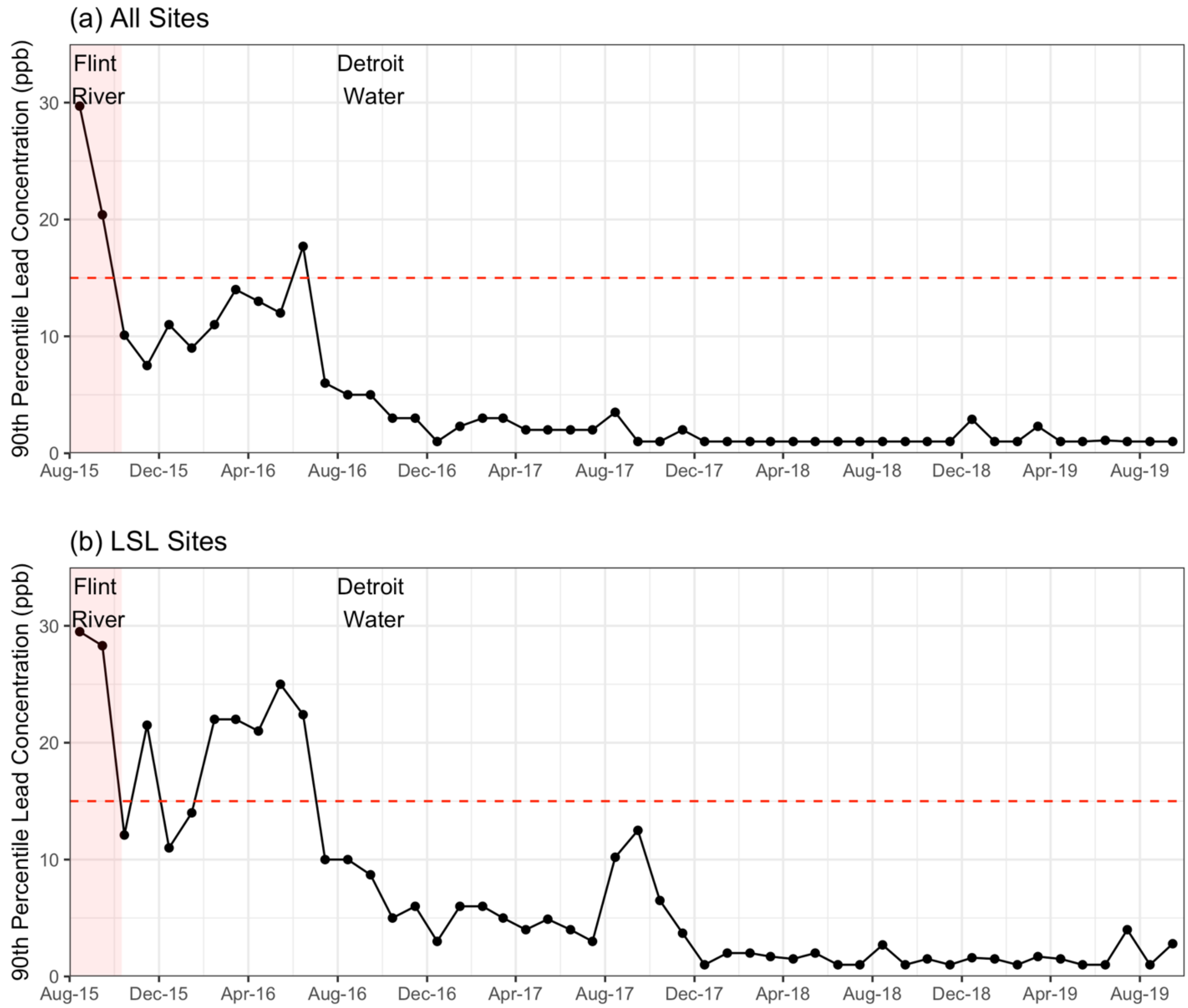

Figure 17. Monthly 90th percentile lead concentration

As shown in Figure 18, the lead levels in Flint are within the range of other large cities with LSLs that are supplied by surface water treated with orthophosphate (Bradley and Horscroft, 2018; DC Water, 2023). The Flint lead results shown in Figure 18 are also within the range of results from Detroit (90th percentile in 2008, 2011 and 2014 were 4.8 ppb, 3.4, ppb and 2.3 ppb, respectively) prior to the new sampling protocol specified in the MI LCR (Detroit Water and Sewerage Department, 2018).

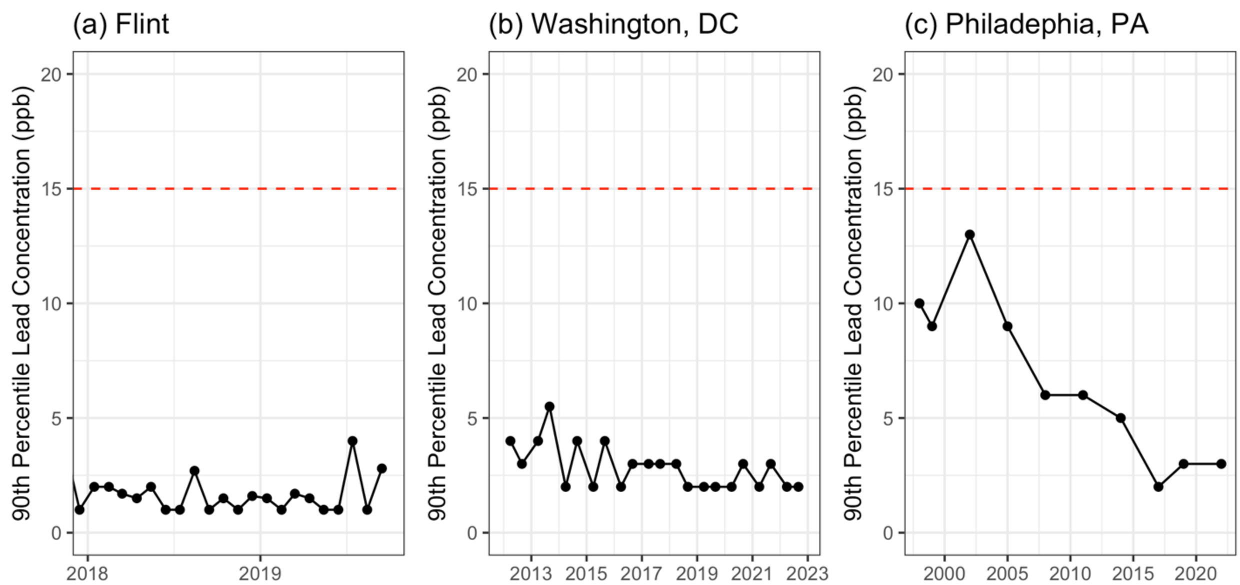

Figure 18. Lead levels from Tier 1 sites from Flint and two of cities (Washington, DC and Philadelphia, PA) supplied by surface water treatment with orthophosphate.

In summary, since there were no reliable LCR monitoring results for lead before August 2015, biosolids analysis retrospectively determined that the worst lead release occurred between June-September 2014. This was also confirmed by blood lead data. Water lead data after July 2015 showed that it took almost a year after the switch back for lead release to remain consistently below the action level. Today, Flint has historically low water lead levels from all lead sources.